Description

METHOD FOR WRITING DATA ONTO AN OPTICAL STORAGE MEDIA

BACKGROUND OF INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a method for writing data onto an optical storage medium, and more particularly, to a method for writing data onto an optical storage medium according to an EFM waveform containing a previous land section, a current pit section, and a next land section.

[0003] 2. Description of the Prior Art

[0004]

As the calculation capability of computers becomes faster and faster andas network technology development progresses rapidly, using the computer as a multimedia interface and as a platform for internet accessis becoming increasingly popular with all types of users. As a result, demand for mass storage devices is rapidly increasing. Devices utilizing optical storage media such as CD-R (Compact Disk-Recordable) are preferred for such kinds of storage as this mediatype is more inexpensive, compact, and portable than other types with

respect to the same storage capacity. As various kinds of optical disk drives and burners appear with faster speed and more reliable operation, and moreparticularly, as DVD-R (Digital Versatile Disk-Recordable) appear with the same physical sizebut withmany times the storage capacity of CD-R, optical disk drives and burners have practically become standard accessories of the personal computer.

[0005]

When an optical storage device such as a CD Burner or a DVD Burner writes data to an optical storage medium such as the CD-R or the DVD-R, the data is transformed into a storage format of the optical storage medium using an encoder of the optical storage device. In the prior art, the data format of the optical storage medium is usually the RLL Modulation (Run-Length Limited Modulation). For example, an EFM Waveform (Eight-to-Fourteen Modulation Waveform) encodes the data to be stored in the optical storage medium using a square wave of various waveform lengths (pulse-widths and intervals) along a time axis. For the CD-R, the pulse-widths and the intervals of the square waves are all multiples of an EFM base period, ranging from three times the base period to eleven times the base period, and the optical storage device writes the data to the optical storage medium according to the EFM Waveform. When the data is stored in the optical storage medium, a plurality of land sections and pit sections of various lengths on the optical storage medium are utilized to represent the data, and the lengths of the land sections.The pit sections correspond with the waveform lengths of the EFM Waveform.

According to this relationship, the optical storage device can write the data onto the optical storage medium.

[0006] In practice, the optical storage device transforms the EFM Waveform into a write time waveform for driving an optical pickup according to a set of write strategy parameters. For a CD-RW (CD-ReWritable), before the optical storage device writes data, the write time waveform is set to an erase power state (to erase previously written signals and reform the land section). When the optical storage device writes data, the write time waveform is set to a bias power state and inserted with a plurality of serial pulses (to form the pit sections), and each pulse switches the write time waveform from the bias power state to a write power state. Meanwhile, the write strategy parameters define the pulse-widths and the intervals under different conditions of the land sections and the pit sections.

[0007] In the prior art, the write strategy parameters define the write time waveform according to a 1T strategy. That is, a length of a period of the pulses of the write time waveform is equal to a length of one EFM base period. However, as the burning technology of the optical storage device increases, and more particularly, as more and more optical storage devices with higher writing speeds appear (for example, 32x and 48x writing speed burners), the EFM base period has become shorter and shorter so that the interval (at the bias power state) after each pulse (at the write power state) of the write time waveform is not long enough to allow the chemicals on the surface of

the optical storage medium to properly solidifyto form the pit section without distortion. In order to solve this problem, the prior art describes a 2T strategy (Orange Book Part III, Volume 3). According to the 2T strategy,the length of the write time waveform pulse period is equal to twice the EFM base period, and therefore, the interval after each pulse is long enough to leave the chemicals on the surface of the optical storage medium properly solidified and form the pit section without distortion.

[0008] According to the 2T strategy described in the prior art, the write strategy parameters are determined simply according to the length of the current pit section of the EFM waveform.The current pit section of the EFM waveform corresponds to the current pit section on the surface of the optical storage medium. The influences of the previous land section (prior to the current pit section) and the next land section (after the current pit section) on the current pit section writing result are not considered. In addition, the pulse-widths and intervals of all but the last pulse are constants according to the 2T strategy.Only the parameters relating to the last pulse can be adjusted, hence there is a very limited degree of freedom to adjust the write strategy parameters to adequately eliminate jitters of the current pit sections due to internal inaccuracies of the optical storage medium.

SUMMARY OF INVENTION

[0009]
It is therefore a primary objective of the claimed invention to provide a method for writing data onto an optical storage medium according to

the information of an EFM waveform containing a previous land section, a current pit section, and a next land section, so as to solve the above-mentioned problem.

[0010] Provided according to the claimed invention is a method adapted to an optical storage device for writing data to an optical storage medium. The optical storage device has a memory and a pickup. The memory stores a plurality of sets of write strategy parameters. The method further comprising: providing an EFM Waveform (Eight-to-Fourteen Modulation Waveform) to the optical storage device, the EFM Waveform including a previous land section, a current pit section, and a next land section; choosing a set of write strategy parameters from the plurality of sets of write strategy parameters stored in the memory according to waveform lengths of the previous land section, the current pit section, and the next land section; generating a write time waveform according to the chosen set of write strategy parameters; and driving the pickup with the write time waveform, so as to write data corresponding to the EFM Waveform to the optical storage medium.

[0011] According to the claimed invention, the method includes choosing a corresponding set of write strategy parameters according to information of a previous land section, a current pit section, and a next land section of an EFM waveform. When the set of write strategy parameters is chosen, not only the information of the current pit section but also that of the previous land section and the next land

section is considered so that a more accurate control over the lengths of the land sections and the pit sections can be achieved. In addition, the method of the present invention defines the write strategy parameters in great detail so that there is higher degree of freedom to adjust the write strategy parameters to adequately eliminate jitters of the current pit sections due to internal inaccuracies of the optical storage medium.

[0012] These and other objectives of the present invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0013] Fig.1 is block diagram of a high-speed optical recording apparatus according to the present invention.

[0014] Fig.2 is a flowchart of a method for writing data onto an optical storage medium according to the present invention.

[0015] Fig.3 is a waveform diagram of write strategy parameters for a 2T strategy according to the present invention.

[0016] Fig.4 is a flowchart of the method of choosing a set of write strategy parameters of Step 12 in Fig.2.

DETAILED DESCRIPTION

[0017] The present invention provides a method adapted to an optical storage device for writing data to an optical storage medium wherein

the optical storage device has a memory and a pickup, and the memory stores a plurality of sets of write strategy parameters. For example, in a first embodiment of the present invention, the optical storage device is a CD Burner (Compact Disk Burner) and the optical storage medium is a CD-RW (CD-ReWritable). In another embodiment, the optical storage device is a DVD Burner (Digital Versatile Disk Burner) and the optical storage medium is a DVD-R (DVD-Recordable) or a DVD-RW (DVD- ReWritable). Although the present invention will be described in the contextof an EFM Waveform (Eight-to-Fourteen Modulation Waveform), this is not a limitation. An optical storage utilizing another RLL Modulation Waveform (Run-Length Limited Modulation Waveform),which does not hinder the actualization of the present invention,is also an embodiment of the present invention.

[0018]

Please firstly refer to Fig.1 showing a block diagram of a high-speed optical recording apparatus 110 according to the present invention. The high-speed optical recording apparatus 110 is installed in the optical storage device for generating a write signal according to an RLL Modulation Waveform input to the high-speed optical recording apparatus 110, so as to control a writing power of the pickup 132 in the optical storage device. As shown in Fig.1, the high-speed optical recording apparatus 110 includes: a clock generator 112 for generating a first clock signal CLK_1, an adjustment data storage unit 114 (the above mentioned memory 114) for storing a plurality of sets

of write strategy parameters, a rough delay unit 116 electrically connected to the clock generator 112 and the adjustment data storage unit 114 for receiving the first clock signal CLK_1, and a fine delay chain 118 electrically connected to the rough delay unit 116. The fine delay chain 118 has a plurality of serially connected delay cells and each delay cell is for delaying a signal by a predetermined period.

[0019] The clock generator 112 further generates a second clock signal CLK_2; and the rough delay unit 116 further comprises: a delay adjustment state machine 120 electrically connected to the clock generator 112 and the adjustment data storage unit 114to receive the second clock signal CLK_2, and a rough delay counter 122 electrically connected to the clock generator 112 and the delay adjustment state machine 120to receive the first clock signal CLK_1. The high-speed optical recording apparatus 110 further comprises: a channel bit(EFM; Eight-to-Fourteen Modulation for CD) input interface 124 for receiving the NRZIchannel bit waveform from an encoder 128 and generating an address signal; and a data storage setting interface 126 electrically connected to the adjustment data storage unit 114, and further electrically connected to a microprocessor 130 of the optical storage device to receive the sets of write strategy parameters and storing the sets of write strategy parameters into the adjustment data storage unit 114. In addition, the fine delay chain 118 is electrically connected to the pickup 132.

[0020] Please refer to Fig.1 and Fig.2. Fig.2 is a flowchart of a method for

writing data onto an optical storage medium according to the present invention. The flowchart of Fig.2 is described as follows.

[0021] Step 10:Provide an EFM waveform through the EFM input interface 124 to the optical storage device, the EFM waveform including a previous land section, a current pit section, and a next land section;

[0022] Step 12:Choose a set of write strategy parameters from the plurality of sets of write strategy parameters stored in the memory 114 with the hardware of the high-speed optical recording apparatus 110 (referring to the coming description of Fig.4) according to waveform lengths of the previous land section, the current pit section, and the next land section;

[0023] Step 14:Generate a write time waveform with the rough delay unit 116 according to the chosen set of write strategy parameters; and

[0024] Step 16:Drive the pickup 132 with the write time waveform converted (that is, delayed) by the fine delay chain 118, so as to write data corresponding to the EFM waveform to the optical storage medium.

[0025] As previously mentioned, the EFM waveform corresponds to a plurality of pit sections representing the data and land sections on the optical storage medium. The EFM waveform has pit sections and land sections corresponding to the pit sections and the land sections on the optical storage medium. For example, a logic high of the EFM waveform represents a pit section and a logic low of the EFM waveform represents a land section. In addition, waveform lengths of

each pit section and each land section are all multiples of the EFM

base period, ranging from three times the base period to eleven times

the base period. Each current pit section on the optical storage

medium corresponds to a current pit section of the EFM waveform, a

previous land section of the EFM waveform prior to the current pit

section of the EFM waveform, and a next land section of the EFM

waveform after the current pit section of the EFM waveform.

[0026] The major difference between the method according to the present

invention and the prior art is located in Step 12. Step 12 comprises

the step of choosing a set of write strategy parameters from the

plurality of sets of write strategy parameters stored in the memory 114

according not only to a waveform length of a current pit section but

also to waveform lengths of a previous land section and a next land

section. The write strategy parameters define the pulse-widths and the

intervals under different conditions of the land sections and the pit

sections, so that in Step 14 a write time waveform according to the

chosen set of write strategy parameters is able to be generated. As

mentioned, the write time waveform is formed with a sequence of

pulses switching the power of the write time waveform between an

erase power state P_E, a bias power state P_B, and a write power state

P_W. The erase power state P_E, the bias power state P_B, and the write

power state P_W of the write time waveform are predetermined values

which are independent of the EFM waveform inputted.

[0027] Please refer to Fig.3 showing a waveform diagram of write strategy

parameters of a 2T strategy modified according to the present invention.The method of choosing the set of write strategy parameters is described as follows.In the preferred embodiment of the present invention a method of defining the write strategy parameters according to the 2T strategy is used. That is, the length of a pulse period of the write time waveform according to the 2T strategy is equal to a length of twice the EFM base period. In Fig.3, a distance between any two consecutive dashed vertical lines is equal to one EFM base period.An EFM waveform with a length of a current pit section which is equal to a length of eleven times the base period (11T) is shown for example. According to this, the write strategy parameters defined in the method of the present invention are shown with the write time waveform of Fig.3 and will be described in detail as follows.

[0028]

The method of the present invention defines several parameters, a first parameter d_1 representing a delay from a leading edge of the current pit section to a leading edge of a first pulse of the write time waveform.A second parameter β_1 represents a delay from a trailing edge of the first pulse of the write time waveform to a leading edge of the next pulse of the first pulse.A plurality of repeating pulse parameters α_2, α_3, α_4,...... represents pulse lengths of all but the first pulse and the last pulse, a length between leading edges of any two consecutive pulses among all but the first pulse and the last pulse being equal to twice the length of the base period.A third parameter d_m represents a delay from a position twice the base period beforethe

trailing edge of the current pit section to the leading edge of the last pulse of the write time waveform.A fourth parameters α_m representsthe length of the last pulse of the write time pulse.Finally, a fifth parameter d_b represents a delay from a position one base period before the trailing edge of the current pit section to the position where the write time waveform switches back to the erase power state. Note that the plurality of repeating pulse parameters α_2, α_3, α_4,...... can be equal to one another or not, depending on different embodiment choices.

[0029] Other characteristics of the write time waveform of Fig.3 can be derived from the write strategy parameters defined above. For example, a length of the first pulse α_1 of the write time waveform is equal to a length of twice the base period subtracting the first parameter d_1 (that is, $\alpha_1 = 2T - d_1$).A delay from a trailing edge of any but the first and the last pulses to a leading edge of the next pulse is equal to a length twice the base period subtracting a length of the pulse (that is, $\beta_2 = 2T - \alpha_2$, $\beta_3 = 2T - \alpha_3$,......).Furthermore, a delay from the trailing edge of the last pulse of the write time waveform to the pointwhere the write time waveform switches back to the erase power state P_E is equal to the fifth parameter d_b plus a length of one base period T subtracting the third parameter d_m subtracting the fourth parameter α_m (that is, $\beta_m = d_b + T - d_m - \alpha_m$).

[0030] Please refer to Fig.1 and Fig.4. Fig.4 is a flowchart of the method of choosing a set of write strategy parameters of Step 12 in Fig.2,

wherein the plurality of the write strategy parameters stored in the memory 114 include a plurality of first parameters d_1, a plurality of second parameters β_1, a plurality of sets of repeating pulse parameters $\alpha_2, \alpha_3, \alpha_4, \ldots\ldots$, a plurality of third parameters d_m, a plurality of fourth parameters α_m, and a plurality of fifth parameters d_b. The method of Fig.4 comprises the following steps.

[0031] Step 20:Determine waveform lengths of the previous land section, the current pit section, and the next land section with the rough delay unit 116 cooperated with the EFM input interface 124 and the memory 114 according to the EFM waveform;

[0032] Step 22:Choose with the rough delay unit 116 a first parameter d_1 from the plurality of first parameters d_1 according to waveform lengths of the previous land section and/or the current pit section, and a second parameterβ_1 from the plurality of second parameters β_1 according to waveform lengths of the previous land section and/or the current pit section;

[0033] Step 24:Choose a set of repeating pulse parameters $\alpha_2, \alpha_3, \alpha_4, \ldots\ldots$ from the sets of repeating pulse parameters with the rough delay unit 116 according to a waveform length of the current pit section;

[0034] Step 26:Choose a third parameter d_m from the plurality of third parameters d_m with the rough delay unit 116 according to waveform lengths of the current pit section and the next land section, choose a fourth parameter α_m from the plurality of fourth parameters α_m with

the rough delay unit 116 according to the waveform length of the current pit section, and choose a fifth parameter d_b from the plurality of fifth parameters d_b with the rough delay unit 116 according to the waveform lengths of the current pit section and the next land section;

[0035] Step 28:Form the chosen set of write strategy parameters with the chosen first parameter d_1, the chosen second parameter β_1, the chosen set of repeating pulse parameters α_2, α_3, α_4,......, the chosen third parameter d_m, the chosen fourth parameter α_m, and the chosen fifth parameter d_b , the formation of the chosen set of write strategy parameters relies on the cooperation of the rough delay unit 116 and the fine delay chain 118.

[0036] Of concern, although a trailing edge of the first pulse of the write time waveform is in alignment with a position twice the base period posterior to a leading edge of the current pit section as shown in Fig.3, this is not a limitation. In another embodiment, a trailing edge of the first pulse of the write time waveform can be in alignment with a position of a leading edge of the current pit section.

[0037] In contrast to the prior art, the present invention method for writing data onto an optical storage medium using an optical storage device can choose a corresponding set of write strategy parameters from a plurality of sets of write strategy parameters stored in a memory.The choice is made according to information of the previous land, the current pit, and the next land of an EFM waveform provided;more specificallythe chosen set of write strategy parameters is determined

according to not only the information of the current pit section but also that of the previous land section prior to the current pit section and the next land section after the current pit section, so that a more accurate control over the lengths of the land sections and the pit sections on a surface of the optical storage medium can be achieved. In addition, the present invention method utilizes the2T strategy and defines the write strategy parameters in great detail, so that the solidifying time shortage problem of the 1T strategy is solved and there is higher degree of freedom to adjust the write strategy parameters to adequately eliminate jitters of the current pit sections due to internal inaccuracies of the optical storage medium.

[0038] Those skilled in the art will readily observe that numerous modifications and alterations of the device may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.